AD NUMBER
AD077345
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DSTL, WO 189/816, 5 Mar 2009; DSTL, WO 189/816, 5 Mar 2009

AD NUMBER

AD077345

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COGNITIVE AND EMOTIONAL CHANGES AFTER EXPOSURE TO GB

B. CLARKE

PORTON TECHNICAL PAPER No. 488

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Copy No. 70
Date 28 SEP 1955

Cognitive and Emotional Changes after Exposure to GB

by

B. Clarke

SUMMARY

Eight men were exposed to GB vapour inhalation, at a dosage (Ct) of 14.6 mg.min/m^3 (t = 1 min. 57 sec.).

Before exposure and 5 hrs. after exposure they completed cognitive tests of verbal and performance types, and they were also required to complete questionnaires giving subjective assessments of emotional and other traits. Thirteen men were used as controls, undergoing the same procedures with the exception of the vapour exposure.

A slight fall-off in manual dexterity was observed, but this may have resulted from muscular incoordination rather than from defect of cerebration. The self-ratings of the volunteers subjected to GB vapour inhalation showed a change of mood in the direction of dysphoria.

The possible impact of mood and motivation in relation to efficiency, with particular reference to the time since exposure, is discussed.

It is suggested that most of the intellectual disabilities and lowered efficiency observed are better seen as behavioural rigidity under stress than as cognitive defects directly due to the cerebral effects of exposure.

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Estimation of whole-blood cholinesterase from samples taken before and an hour after exposure gave the following table. (The method of estimation was that described by Aldridge and Davies (1954)).

Subject	Before	After	Percentage Loss
1	137	87	36.5 %
2	129	75	51.9
3	137	82	40.2
4	141	104	26.2
5	131	85	35.1
6	122	72	41.0
7	119	87	26.9
8	142	92	35.2

Mean percentage loss = 35.4%

Test Procedures

These consisted of three pencil and paper tests (perceptual analogies, verbal analogies, and a mirror-image test ("k-factor")): a "Medical and Personal Questionnaire" (M.P.Q.3, used before in this connection) - this was given once at the beginning: a self-rating list of 102 traits, completed twice: four Kohs' Blocks designs, three easy and one harder: and an individual dexterity test referred to as Washer Crib and described below.

(The experimental group was being tested for another purpose for simple visual and auditory reaction times and for auditory-visual discrimination reaction time. There were some technical objections to these particular measures, so the controls were not given the tests; and the changes in experimental subjects' scores cannot be profitably assessed.)

The three pencil and paper tests were presented in parallel forms before and after exposure. That is, the form was exactly the same but the actual items differed, in order to keep the task fresh. Using the same test twice, one studies differential rates of largely specific learning. Using variants, one matches up the levels of difficulty and more general learning on the control group, as an alternative guide to changes in the experimental subjects' performance.

The check on the neurotic questionnaire gave means for the two groups as: Experimental Group = 11.2; Controls = 6.5. These are both inside the normal range 0 - 15. The neurotic mean is 21, and the difference between groups is not of consequence.

RESULTS

Cognitive effects

'Cognitive' is defined here by the paper test scores just described. The comparisons were made by computing the ratio of the second control mean to the first, and then multiplying the experimental groups first scores by this factor, to obtain expected scores. These were then compared with the actual scores obtained on the parallel tests at 5 hours and at 24 hours after exposure. The table below summarises the data, from which it can be seen that actual scores tend to fall slightly below the expected level, but that

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this does not reach clear significance. Thus there is not a great deterioration in central cognitive functioning at 5 hours from exposure: but the fact that the 24-hour figures also are not quite up to expectation, though some recovery occurs, suggests that at least there probably was enough interference on the earlier occasion to flatten the learning curve a little, even though the figures are not unambiguous. It should be emphasised that motivation and willingness to make an effort were good during these test sessions: this is important in view of the self-ratings described below, which were not a challenge to do well, as tests are.

These findings are in line with the previous ones by the author at this dosage, using a similar set of tests, including the same kind of non-verbal G test, a perceptual analogies (not similarities) test with creative answers. Coombs and Freeman also found that performance on 6 of their Wechsler subtests were less but not significantly less than control scores for their 'higher-exposure' group. They found that two verbal tests did drop significantly: this agrees with Steinberg's (1954) finding that higher-verbal intelligence was most susceptible to a general depression of cerebral functioning - due in her cases to nitrous oxide. This result is not apparent in the present series; and Coombs' and Freeman's testing conditions - 4 hours to 2 days after an exposure of unknown severity - leave the matter open, especially as they agree on the possibility of some emotional effects operating to lower performance.

TABLE 1

Cognitive tests: Actual and Expected Means

(Experimental Group N = 8)

G = Perceptual Analogies
V = Verbal analogies
K = Mirror-image spatial relations

Trial	Before x	5 hrs. after xx	24 hrs. after xx
G: Expected	-	20.6	21.9
Actual	(18.8)	18.0	20.0
V: Expected	-	10.6	13.4
Actual	(13.1)	9.8	13.0
K: Expected	-	20.1	21.7
Actual	(16.4)	20.4	19.4

(All expected/actual differences are N/S)

x Form I of the tests) Do not compare these
xx Form II of the tests) scores directly

Psychomotor effects (Performance Tests)

Kohs' Blocks

The Kohs' Blocks are included under this heading. In their Wechsler form, they, like the Digit Symbol sub-test, are often sensitive pointers to the existence of intellectual deterioration due to organic causes, especially when compared with verbal tests. Combs and Freeman note this, but curiously refer to both these tests in their conclusions as tests of "old, factual learning", in the same class as Wechsler verbal tests.

The Table below shows the means of both groups on the two trials. The three easy ones are averaged.

TABLE 2

Kohs Blocks

	Easy (3 designs) Means (secs)		Hard (1 design) Means (secs)	
	EXPL.	CONTR.	EXPL.	CONTR.
Trial I (or before)	19.9	25.9	72.4	69.1
Trial II (or after)	25.5	18.2	70.8	58.9
% Improved Deteriorated	-28.1%	+29.7%	+ 2.2%	+ 9.5%

An interesting point emerges here. If a temporary general intellectual decline occurs, one would expect it to be more evident in the performance on the difficult design: just as the improvement of the controls with practice is less on the hard design. But the experimental subjects fall badly on the easy designs and make a small improvement on the hard one.

This seems referable to the only change in administration between trials I and II - namely that for both groups the designs were presented on the second occasion rotated through 90°, for a similar reason to that advanced above for the paper-test variants. The controls took this in their stride and were not prevented from improvement. The exposed subjects blocked, complained of poor concentration, made false starts; but recovered by the time they came to the hard design, on which they improved a little but not so much as the controls. The last point suggests a very small decrement of competence (as the paper test results did), but the blocking, etc., only on the easy designs suggests that this is better interpreted as a reaction to a minor unexpected stress, - in kind but not degree not unlike Goldstein's "catastrophic reaction" observed among brain-damaged patients coming up against their disabilities.

Thus from the Kohs' Blocks results it seems (i) that a small decrement of ability can be supposed and (ii) that subjects had a certain rigidity of 'set' towards the task, which made them less adaptable to a minor change: put another way, more generalised learning, or transfer, was affected.

This fits in with some (unpublished) experiments on rats (Watson, personal commn.), in which behavioural rigidity was a clearer guide to the effects of feeding over a period on a diet containing Systox than the results of straightforward studies of test-efficiency. In particular, slowness in the extinction of a conditioned response was noted.

Washer Crib

This is a manual dexterity test combining with a discrimination task: it has some similarity to the Purdue type of dexterity test. Briefly, the apparatus is a board about 12" x 6", with two parallel rows of 10 1" pins running lengthways, with two rows of holes running across one end. As used, the subject faced this with the pin-rows running sideways. His task was to take flat metal washers out of a box in front of him - singly, with alternate hands - and put 10 on each pin. The direction was changed between trials. After each ten he selected a wooden peg from a heap of 40 and put it into one of the holes. The pegs had a bi-coloured top and the subject had to select a given combination alternating with its complementary: e.g., red-over-yellow alternating with yellow-over-red. There were three colours in six combinations in the mixed heap. Two sizes of washer were employed - with 3/15" and 1/8" holes. Under these conditions the numbers of washers placed in 90 seconds and the numbers of correct pegs were noted; but only the former are used for calculating changes. The Table shows percentage of loss or improvement on the two trials.

TABLE 3

WASHER CRIB

Mean number of washers placed per trial

Trial	Washers I	Washers II	Percentage Increase/Decrease
Large: EXPL.	46.9	47.9	+ 2.1%
3/16" CONTR.	51.6	57.5	+11.4
Small: EXPL.	41.2	37.5	- 9.0%
1/8" CONTR.	42.7	47.3	+10.8

Here the controls improve to the same degree on both stages of the trial. The exposed men improve to a much smaller degree on the larger washer but on the smaller ones fall off quite sharply, considering the expected improvement (which would have been to an average of 46). Visual symptoms did not seem to be incommoding them on the second trial, and motivation seemed adequate. But a slight finger incoordination was in evidence, and this may account for as much of the fall-off as cerebral sluggishness.

Mood and Personality

An attempt was made to not some of the subjective changes which accompany the after-effects of exposure.

The outward picture was as before: a degree of lethargy and open discomfort over eye symptoms, but a tendency to become better by the end of the 5 hour period, and even be a moderately cheerful group.

A self-rating list was given to both sets of subjects at both trials. They were asked to check straight through a list of 102 traits (represented by 102 adjectives) and to make a self-description by marking every trait which applied to them individually. The emphasis was placed on their 'real personality' rather than on the transient mood of the moment (this was a feint); but a firm distinction was avoided, and the instructions kept as closely as possible to the simple form, "Mark every word which applies to you".

The trait-list used was special to the occasion but covered much the same wide ground as Cattell's list (Cattel, 1946; see Monro, 1954), but no headings or groupings of traits were employed. Some words were of course more familiar than others: but only one word ("curious" = inquisitive or feeling queer) was found to be ambiguous in meaning - due to the special context. (Such trait-lists are an important tool in certain factorial approaches to the study of personality).

The technique used was to study only the differences between lists completed at trials I and II. That is to say, the basic individual differences of the personalities concerned do not come into the picture: we are only interested in the effect on their self-ratings of common situational changes. (The control group here were eight of the full set of controls, those who were the best match for the exposed subjects on other grounds.

Lists were checked and note was made (a) of traits marked in the first trial but not in the second, and (b) vice-versa. Traits marked in both were not recorded, as just explained. The lists of the two groups were then compared and four "operative" lists were drawn up showing those positive (and negative) changes on which controls were more numerous than exposed subjects (and vice-versa), and by how many.

Finally, the trait-changes were arranged according as they referred to changes of mood, mental alertness, or sociability, and according to the direction of change in these categories. Table 4 gives the mood lists as an example, without frequencies; the 'Not' sections are the negative changes - traits which had dropped out.

TABLE 4

Self-Rating Changes

Mood Lists

(+) "SURGENT" (Well-being) (Confidence) (etc.)		(-) "DYSPHORIC" (Desurgency) (Depression) (Anxiety, etc.)	
Control	Expl.	Control	Expl.
Comfortable	Calm	Disgusted	Complaining
Energetic	Excited		Dissatisfied
Enthusiastic	Good-tempered		Frustrated
Gay	Relieved		Humourless
Gentle	Self-controlled		Brooding
Happy			
Jolly			
Not:	Not:	Not:	Not:
Self-pitying	Angry	Hearty	Amused
	Anxious	Keen	Vigorous
	Brooding	Pleased	Cheerful
	Moody	Relieved	Content
	Pessimistic	Self-controlled	Vivacious
	Tearful	Strong	Frivolous
	Dissatisfied		Self-confident
	Worrying		Happy
	Grim		Lively
			Mischievous
			Sad
			Irritable
			Ghastly
			Shaky
			Queer
			Optimistic
			Calm
			Comfortable
			Resolute
			Energetic
			Gay
			Genial
			Irresponsible
			Tough

TABLE 5

Self-Rating Changes

A: Mood

	Control	Expl.	
SURGENT: (Well-being, Confidence, etc.)	12	19	31
DYSPHORIC: (Desurgency, Depression, Anxiety)	10	47	57
P = .03	22	66	88

B: Mental Alertness

	Control	Expl.	
Mean Normal	2	4	6
Mean Reduced	2	14	16
N.S.	4	18	22

C: Sociability

	Control	Expl.	
Outgoing	5	11	16
Withdrawing	2	28	30
P = .06	7	39	46

All these tables can be seen to be of the same form, with the heaviest weighting in the lower right cell. They demonstrate a tendency for the exposed men to feel more dysphoric, less alert (though this table, which was corrected for small numbers, does not approach statistical significance), and to withdraw more.

This picture bears out much of what was observed, and fits in with evidence like that of the 1953(b) report on 'judgment' and 'aspiration' scores and their relation to self-confidence. Moreover, it clarifies the important point that the tendency to sociability and cheerfulness at the 5-hour mark

after exposure was more apparent than real, and a sign of an individual need for support rather than of group cohesiveness. As noted earlier, there was a special effort when it came to the tests proper; and this difference tends to give more confidence in test scores as reliable cognitive measures.

Some secondary cross-currents, like a slight negative mood-change in the controls which reduced but did not mask their difference from the experimental subjects, seemed to be detectable in the self-ratings, but these were not pursued.

SUMMARY AND CONCLUSIONS

1. Eight men were exposed unprotected to GB vapour, at a dosage (Ct.) of 14.6 mg.min/m^3. Before and after exposure they completed verbal type and performance type cognitive tests, and psychomotor tasks, and were assessed for changes of mood, alertness, and social participation on a self-rating inventory. Control values for practice effects and other changes were provided by thirteen very similar men who carried out the same procedures but were not exposed.

2. Findings were:

(a) that no serious central intellectual fall-off was in evidence 5 hours after exposure on any of the tests of g, v, and k factors employed:

(b) that the Kohs' Blocks designs, sensitive to the effects of impaired brain function, showed a sharp difference between groups on the easier items and a smaller one on the harder section; and this was taken to mean (i) that there was probably a small decline in cognitive efficiency, but (ii) that the large drop in scores on easier items was in the nature of a reaction to the minor stress of an unexpected change in procedure and indicated a rigidity of mental set, such as has been noted experimentally and clinically under certain kinds of stress:

(c) that there was a reduced improvement with practice on the manual-dexterity/discrimination task "Washer Crib" which may have been due to a slight finger incoordination, as much as to difficulties of cerebration:

(d) that, from self-rating changes, a marked mood change of a dysphoric kind was persisting, combined with a feeling of reduced mental alertness and a tendency to social withdrawal; and that the outward signs of partial recovery of morale and group cheerfulness were superficial.

3. It is emphasised that the studies so far made, here and elsewhere, of depression of cognitive functions after exposure to moderate dosages of nerve gas agents have referred to the condition of subjects at least several hours later. By this stage changes of mood and motivation are apparently more important than cognitive disability due to organic causes - though, of course, emotional upsets can have as severe an inhibitory effect on efficiency. But it still remains unknown whether an intellectual deficit (referable to direct effects of the toxin and not merely to emotional causes) occurs between exposure and five hours. Observation of men in the field soon after dosages of this order suggests that no dramatic effect would be found. But if it is greater than is found at the five-hour mark, it might be of practical consequence in this critical period just after exposure.

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Date of Search: 5 March 2009

Record Summary: WO 189/816
Title: Cognitive and Emotional Changes After Exposure to GB
Availability Open Document, Open Description, Normal Closure before FOI Act: 30 years
Former reference (Department) PTP 488
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